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Tibial Cut Strategy for Mitigating Workspace Limit Risk for Surgical Robots

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THINK Surgical, Inc. - Micah Forstein & Amit Sandhu

Introduction: A robotic surgical system generally includes: a pre-operative planning software program to generate a surgical plan having a desired position for an implant relative to a bone; and a surgical robot to execute the plan on the patient's bone. One such robotic system is the TSOLUTION ONE® Surgical System manufactured by THINK Surgical, Inc. In the operating room (OR), the surgical plan is mapped onto the bone in the coordinate system of the robotic system such that the end-effector can accurately execute the surgical plan. The surgical plan includes a cut-file, where the cut-file includes a plurality of cutting parameters (cut paths, speeds, accelerations, feed rates, etc.) to control the end-effector's motions to remove a volume of bone to receive an implant as planned. One potential issue that needs to be considered for all robotic surgical procedures is the workspace of the robot. The workspace refers to the working volume of the robot. In short, all the points or cut paths in the cut-file need to be within the robot workspace otherwise the end-effector will not be able to reach those points to remove the required bone. The following description provides a solution to reduce the likelihood of encountering workspace issues for robotic-assisted surgical procedures.

Tibial Cut Strategy for Mitigating Workspace Limit Risks: With reference to Fig. 1, a surgical robot is shown next to a patient's left operative bones (femur and tibia). The workspace of the robot is outlined in which the robot can accurately execute the surgical plan and reach all of the points or cut paths in the cut-file. As shown, the medial side of the tibia (most right portion of the bone in Fig. 1) is near the outer edge of the workspace. Fig. 2 depicts an example of a plurality of cut paths overlaid on a tibial bone. Here, the plurality of cut paths are separated into a first set of cut paths and a second set of cut paths. The first set of cut paths direct an end-effector to remove bone on the lateral side of the tibia while the second set of cut paths direct the end-effector to remove bone on the medial side of the tibia. To mitigate workspace limit risks in this scenario, the cut-file instructions direct the end-effector to execute the first set of cut paths followed by the second set of cut paths. This pushes the highest risk of cutting (medial side being near the edge of the workspace) to the very end of the surgical procedure making the process more manageable in the event the workspace is exceeded when cutting the medial side. The risk is mitigated because the amount of time the robot is fully extended is minimized. This cutting strategy also removes more bone than prior strategies, is more efficient, and supports a higher level of performance. It should be appreciated that other cut-file design strategies may be conceived to accomplish the same goal.

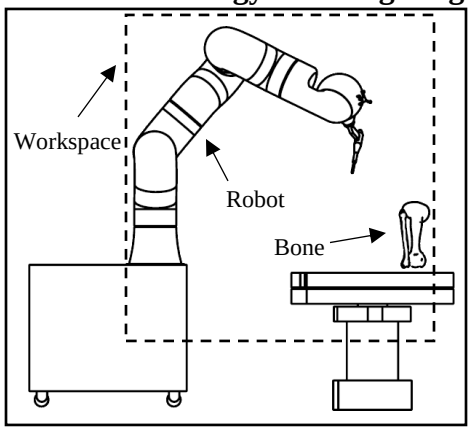

Fig. 1

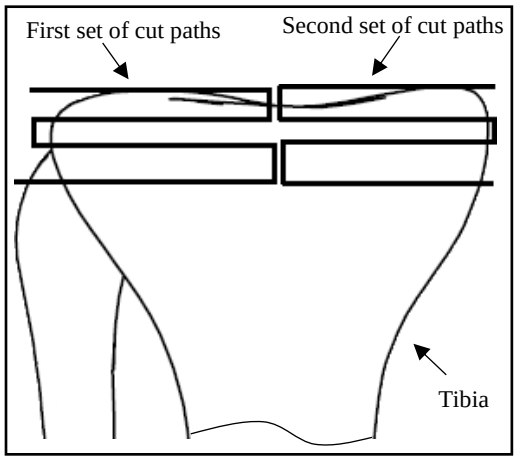

Fig. 2